Semi-Autonomous Flight Environment Tug (SAFETug)

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The predicted growth in air travel demands capacity enhancement in the National Airspace System. Congestion at airports is recognized as one of the most prominent problem areas. Airports are expected to address this problem through expansion of their airfields. However, the addition of runways and taxiways will increase the complexity of air terminals, which will penalize the efficiency of the system, restricting the potential benefits of expansion. The increased complexity will also increase the risk of human error, resulting in potentially hazardous situations. In addition, the increasing number of taxiing aircraft will contribute significantly to an increase in fuel burn and emissions. The quantities of fuel burned as well as different pollutants, such as carbon dioxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulate matter, increase with aircraft taxi duration (and also vary with throttle setting, number of running engines, and pilot and airline decisions regarding engine shutdown during delays).

In this project, we develop the concept of Semi-Autonomous Flight Environment Tug (SAFETug), that investigates the use of a semi-autonomous pushback tugs to tow aircraft from gate to runway and runway to gate. The tug autonomy capabilities will be supervised by ATC controllers, who provide route information to the tugs assisted by an automated route planning system. The planner works in conjunction with the semi-autonomous tugs to make tactical decisions during operations to ensure safe and effective taxiing in a highly dynamic environment. The resulting system is expected to significantly reduce fuel emissions, fuel costs, and community noise, while addressing the added complexity of air terminal operations by increasing efficiency and reducing human workload.

A fully tug-based surface movement system will require three technological innovations: 1) automated strategic and tactical planning that incorporates tug allocation and dispatching; 2) an advanced human machine interface, designed for ATC supervision of the semi-autonomous tugs; and 3) a set of capabilities for enabling autonomous tug navigation. We will conduct a systematic study, through concept design and simulation, of the benefits of using semi-autonomous tugs in airport surface movement operations. Quantifiable metrics related to movement efficiency, human operator workload, safety, and environmental and economic impact will be used to assess the impact of tug-based operations. This proposed approach is expected to provide a significant increase in terminal surface area operations efficiency and safety by exploiting new roles for humans, tugs and automation in the planning and execution of surface operations. The investigating team is comprised of researchers from two NASA centers (JSC and ARC), Lockheed Martin Corporation, and the University of California, with expertise in human interface design, robotics, path planning, and airport surface operations.